EJ-1984

TRUE R.M.S. MILLIVOLTMETER
TYPE 702

INSTRUCTION MANUAL

MP MASTER
MA23515

DYMAR ELECTRONICS LIMITED,
REMBRANDT HOUSE, WHIPPENDELL ROAD, WATFORD, HERTS, ENGLAND.

EJ-1984

TRUE R.M.S. MILLIVOLTMETER
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1. General

Almost all electronic voltmeters of the amplifier-detector type, respond to the average or peak value of an A.C. waveform but are calibrated in terms of r.m.s. values of a sinewave. This can introduce appreciable errors if the shape of the waveform markedly differs from a sinusoid as is the case in assymetrical and spiky pulses etc. To obtain a reading of the true r.m.s. value of such complex waveshapes it is necessary to have elements which respond to the heating effect or alternatively have a square law transfer characteristic.

In the Type 702 Millivoltmeter a pair of fast rectifying diodes operated in the low level region, provide the square law transfer function. This has two main advantages over instruments which use a thermocouple, namely it does not suffer from a long time constant associated with all thermal elements and it is not susceptible to damage from overloads. The D.C. output from the rectifying diodes is amplified in a chopper stabilised amplifier and special linearising circuits are used to correct for the non-linearity of the diodes, so that between 1/3 and full scale deflection the meter reading is linear.

2. Specification

Sensitivity:	1mV f.s.d. to 300V in 12 ranges of 1, 3, 10 sequence.
Frequency Range:	30Hz to 10MHz
Accuracy:	3% of f.s.d. between 100Hz and 2MHz.
Bandwidth ($\pm$0.5db):	30Hz to 10MHz.
Crest Factor Accuracy:	3:1-1% 5:1-3% 10:1-8%
Input Terminal:	Coaxial Socket Type UHF
Input Impedance:	10MΩ all ranges
Input Capacity (Approx.):	30pF mV ranges 18pF V ranges

NOTE 1: Only figures which have a defined tolerance limit are guaranteed, all others are typical figures for an average instrument.

NOTE 2: Meter readings below 1/3 of full scale deflection are uncalibrated and the next lowest range must be selected.

3. Operation

Insert the Plug-In into a Dymar Meter Unit and to obtain full accuracy allow 10-15 minutes from switch-on for the instrument to warm up. With the input terminals shorted to avoid pick-up from stray fields adjust the zero control for minimum deflection on the meter. This should be about two divisions on the upper scale. If difficulty is experienced in zeroing the instrument especially on sensitive ranges, the cause is often mains pick-up via earth loops. This can be eliminated by disconnecting the green earth wire of the mains plug on the Meter Unit.

After zeroing the instrument the voltage to be measured is applied to the input terminals and a suitable range selected to give a reading between one third and full scale deflection on the meter. It is important to remember that below on third f.s.d. the meter can only be used as an indicator and to make a measurement the next range down must be selected.

Although the shielded input socket will accept an unscreened wire with a 4mm banana plug it is advisable to use screened leads, a coaxial plug is provided with the instrument. This is imperative when measuring low level signals as the bandwidth and sensitivity is such that the instrument will pick up stray R.F. fields.

4. Technical Description

The circuit description must be read with reference to the attached circuit diagram of the instrument. The input voltage to be measured is applied at the socket SK1 and on the first six ranges is fed directly to the cathode follower valve V_1. On the other six ranges, i.e. 1 Volt to 300 Volts, it is first attenuated by a factor of 1000:1 in the frequency compensated attenuator consisting of R_2 and R_3 with the associated components. The signal then passes to the intermediate attenuator R14 to R19 which gives five steps of attenuation in 10db increments, i.e. a division ratio of 3.162:1. This attenuator is also frequency compensated and feeds the second cathode follower V_2. Thus the signal level is normalised to one value irrespective of range switch setting and is approximately 0.9mV at full scale reading. (There is a 5% loss in each cathode follower). This signal is now amplified about five times in the wide-band amplifier stage consisting of the transistors VT1 and VT2 to give a level of 4.5mV at full scale deflection. This signal level is applied to the rectifying diodes MR1 and MR2 whose D.C. output is a true square law function of the A.C. input. The resulting small D.C. voltage is then applied to the mechanical chopper CH1 which converts it into a 50Hz square wave and this is the frequency at which the main amplification is obtained.

The first stage of amplification is the conventional feedback pair consisting of the low noise double triode V3A and V3B. The second stage consists of Valves V4, V5A and the cathode follower V5B. There are two distinct feedback paths here, one to stabilise the gain and the other to provide selectivity at the chopper frequency.

Conventional negative feedback is taken from the cathode of V5B via R68 to the cathode of V4. Frequency selective feedback is taken from the junction of R76 and R77 via a "Twin-T" network to the grid of V5A. One "T" consists of R66, R67 and C42 and the other "T" consists of C45, C46 and R71. This network has the property of not passing a frequency of 50Hz thus giving minimum negative feedback at this frequency and hence maximum gain of the amplifier. The reason for this selectivity is to obtain minimum noise bandwidth of the amplifier.

This signal is now rectified by the voltage doubler MR3 and MR4 but since the first detector had a square law transfer characteristic the D.C. signal has to be linearised before applying it to the meter. This is done by the diodes MR5 and MR6 in conjunction with RV4.

5. Maintenance and Calibration.

If maintenance and recalibration of the instrument is required it is necessary to have an extension lead which will permit the Plug-In to be operated outside the Meter Unit case. A calibrated source of voltages is required giving 300μV to 1 Volt in the frequency range 30Hz to 10MHz. The calibrating procedure is as follows.

5.1. Basic sensitivity and linearity.

After zeroing the instrument apply a sinewave signal of 0.3 mV at 400Hz from the calibrated source. With the range switch set to the 1mV range adjust potentiometer RV3 to obtain the correct reading on the meter. Increase the signal to 0.95mV and adjust potentiometer RV4 to get the correct reading. Vary the signal between 0.3mV and 1mV and check that the meter tracks correctly. Maximum permissible error is 1.5% of f.s.d. or 1.5 divisions.

5.2. Input attenuator.

Apply a signal of 0.95V at 400Hz on the 1 Volt range and adjust RV1 for correct reading.
Apply a signal of 0.95V at 20kHz and adjust C5 for correct reading.
Check reading at 10MHz and if necessary change the "Adjust on Test" Resistor R6. This is normally a factory adjustment and should not require readjustment unless other components in the attenuator have been replaced.

5.3. High frequency adjustment of the intermediate attenuator.

Apply a signal of 3mV at 10MHz and on the 3mV range adjust C16 for correct reading.
Apply a signal of 9.5mV at 10MHz and on the 10mV range adjust C17 for correct reading.
The instrument should now be fully calibrated and conform to the design specification.

PARTS LIST

RESISTORS

CIRCUIT REF.	DESCRIPTION			
R1.	Carbon High Stab.	15KΩ	±5%	¼W
R2.	Metal Film	10MΩ	±1%	1W
R3.	Metal Film	9.5KΩ	±1%	¼W
R4.	Solid Carbon	10Ω	±10%	¼W
R5.	Solid Carbon	10Ω	±10%	¼W
R6.	Solid Carbon	A.O.T. 10-68Ω	±10%	¼W
R7.	Carbon	8.2MΩ	±5%	½W
R8.	Carbon	2.2MΩ	±5%	½W
R9.	Carbon	470Ω	±5%	½W
R10.	Carbon	220KΩ	±5%	½W
R11.	Carbon	100KΩ	±5%	½W
R12.	Power Metox	8.2KΩ	±5%	2W
R13.	Power Metox	3.3KΩ	±5%	2W
R14.	High Stab.	1.23KΩ	±½%	¼W
R15.	High Stab.	390Ω	±½%	¼W
R16.	High Stab.	123Ω	±½%	¼W
R17.	High Stab.	39Ω	±½%	¼W
R18.	Metal Film	12.3Ω	±½%	¼W
R19.	Metal Film	5.7Ω	±½%	¼W
R20.	Carbon	8.2MΩ	±5%	½W
R21.	Carbon	2.2MΩ	±5%	½W
R22.	Carbon	47Ω	±5%	½W
R23.	Carbon	220KΩ	±5%	½W
R24.	Carbon	100KΩ	±5%	½W
R25.	Carbon	10KΩ	±5%	2W
R26.	Carbon	10KΩ	±5%	2W
R27.	Carbon	4.7KΩ	±5%	½W
R28.	Carbon	10KΩ	±5%	½W
R29.	Carbon	330Ω	±5%	½W
R30.	Carbon	15KΩ	±5%	½W
R31.	Carbon	1.5KΩ	±5%	½W
R32.	Carbon	3.9KΩ	±5%	½W
R33.	Carbon	3.9KΩ	±5%	½W

CIRCUIT REF.	DESCRIPTION			
	RESISTORS			
R34.	Carbon	1KΩ	±5%	½W
R35.	Carbon	150Ω	±10%	¼W
R36.	Carbon	100KΩ	±10%	¼W
R37.	Carbon	150Ω	±10%	¼W
R38.	Carbon	100KΩ	±10%	¼W
R39.	Carbon	100KΩ	±10%	¼W
R40.	Carbon	220KΩ	±5%	1W
R41.	Carbon	47KΩ	±5%	½W
R42.	Carbon	47KΩ	±5%	½W
R43.	High Stab.	22MΩ	±5%	¾W
R44.	High Stab.	22MΩ	±5%	¾W
R45.	High Stab.	330KΩ	±5%	¼W
R46.	Carbon	10KΩ	±5%	½W
R47.	Carbon	10KΩ	±5%	½W
R48.	High Stab.	330KΩ	±5%	¼W
R49.	High Stab.	5.6MΩ	±5%	¼W
R50.	High Stab.	5.6MΩ	±5%	¼W
R51.	Carbon	2.2KΩ	±5%	½W
R52.	Carbon	6.8MΩ	±5%	½W
R53.	Carbon	1MΩ	±5%	½W
R54.	Carbon	10KΩ	±5%	½W
R55.	Carbon	1MΩ	±5%	½W
R56.	Carbon	47KΩ	±5%	½W
R57.	Carbon	2.2MΩ	±5%	½W
R58.	Carbon	470KΩ	±5%	½W
R59.	Carbon	6.8KΩ	±5%	½W
R60.	Carbon	27KΩ	±5%	½W
R61.	Carbon	1MΩ	±5%	½W
R62.	Carbon	330KΩ	±5%	½W
R63.	Carbon	390Ω	±5%	½W
R64.	Carbon	2.2KΩ	±5%	½W
R65.	Carbon	1MΩ	±5%	½W
R66.	Carbon	200KΩ	±5%	½W

CIRCUIT REF.	DESCRIPTION			
	RESISTORS			
R67.	Carbon	200KΩ	±5%	½W
R68.	High Stab.	560KΩ	±5%	¼W
R69.	Carbon	1MΩ	±5%	½W
R70.	Carbon	1KΩ	±5%	½W
R71.	Carbon	20KΩ	±5%	½W
R72.	Carbon	1MΩ	±5%	½W
R73.	Carbon	220KΩ	±5%	½W
R74.	Carbon	1.2KΩ	±5%	½W
R75.	Carbon	1MΩ	±5%	½W
R76.	Carbon	680Ω	±5%	½W
R77.	Power Metox	20KΩ	±5%	2W
R78.	Power Metox	6.8KΩ	±5%	2W
R79.	Power Metox	62Ω	±5%	2W
R80.	High Stab.	2.7KΩ	±5%	¼W
R81.	High Stab.	100KΩ	±1%	¼W
R82.	High Stab.	9KΩ	±1%	¼W
R83.	Carbon	1MΩ	±5%	½W
	CAPACITORS			
C1.	Foil	.047μF		630V
C2.	Polystyrene	50pF		125V
C3.	Polystyrene	3000pF		125V
C4.	Polystyrene	1000pF		125V
C5.	Trimmer	1-6pF		350V
C6.	Polyester	0.1μF		250V
C7.	Polystyrene	1000pF		125V
C8.	Treble	16μF		275V
C9.	Polyester	.01μF		400V
C10.	Electrolytic	16μF		150V
C11.	Polystyrene	820pF		125V
C12.	Electrolytic	50μF		275V
C13.	Silver Mica	6.8pF		350V
C14.	Silver Mica	4.7pF		350V

CIRCUIT REF.	DESCRIPTION		
	C A P A C I T O R S		
C15.	Polyester	0.01pF	400V
C16.	Trimming	3-30pF	300V
C17.	Trimming	3-30pF	300V
C18.	See C8.		
C19.	Polyester	.01µF	400V
C20.	Electrolytic	8µF	150V
C21.	See C.12		
C22.	Double Electrolytic	50µF	275V
C23.	Electrolytic	125µF	16V
C24.	Silver Mica	3.3pF	350V
C25.	Electrolytic	10µF	16V
C26.	Electrolytic	10µF	16V
C27.	Polyester	.1µF	250V
C28.	Polyester	1µF	250V
C29.	Polyester	2.2µF	250V
C30.	Polyester	2.2µF	250V
C31.	Foil	.1µF	160V
C32.	Foil	.1µF	160V
C33.	Polyester	.0033µF	400V
C34.	Polyester	.022µF	160V
C35.	Ceramic	4700pF	500V
C36.	Polyester	.1µF	250V
C37.	Electrolytic	50µF	12V
C38.	Polyester	.047µF	160V
C39.	Polyester	.1µF	250V
C40.	Electrolytic	100µf	12V
C41.	Polyester	0.1µF	250V
C42.	Foil	.047µF	160V
C43.	Double Electrlytic	32µF	450V
C44.	Polystyrene	2000pF	500V
C45.	Foil	.033µF	160V
C46.	Foil	.033µF	160V
C47.	Polyester	.1µF	250V
C48.	Polyester	.022µF	400V
C49.	Polyester	.1µF	250V

CIRCUIT REF.	DESCRIPTION		
	C A P A C I T O R S		
C50.	Polyester	.1µF	250V
C51.	Electrolytic	50µF	12V
C52.	See C.43		
C53.	Polyester	2.2µF	250V
C54.	Ceramic	.01µF	500V
C55.	See C22.		
C56.	Polyester	2.2µF	250V
C57.	Polyester	1µF	250V
C58.	Polystyrene	15pF	125V
C59.	Polystyrene	120pF	125V
C60.	Polystyrene	270pF	125V
	S E M I C O N D U C T O R S		
MR1.	Diode, Germanium	Transitron	S570G
MR2.	Diode, Germanium	Transitron	S570G
MR3.	Diode, Germanium	Mullard	OA91
MR4.	Diode, Germanium	Mullard	OA91
MR5.	Diode, Silicon	Texas	1S44
MR6.	Diode, Silicon	Texas	1S44
	V A L V E S		
V1.	Pentode	EF91	Mullard
V2.	Pentode	EF91	Mullard
V3.	Double Triode	ECC83	Mullard
V4.	Pentode	EF86	Mullard
V5.	Triode-Pentode	ECF80	Mullard
	T R A N S I S T O R S		
VT1.	Silicon	BF185	Mullard
VT2.	Silicon	BF185	Mullard

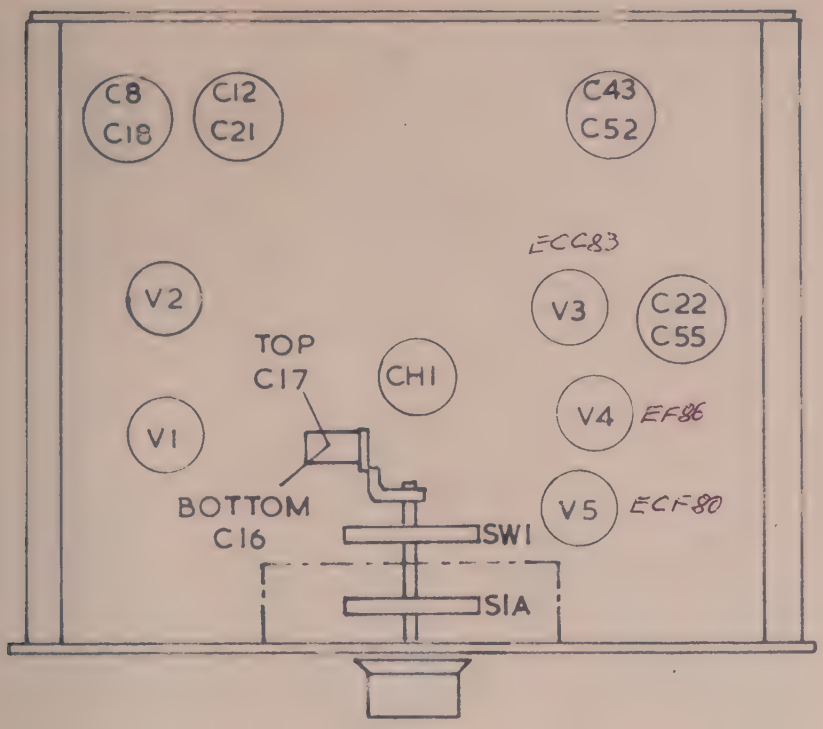
CIRCUIT REF.	DESCRIPTION

P O T E N T I O M E T E R S

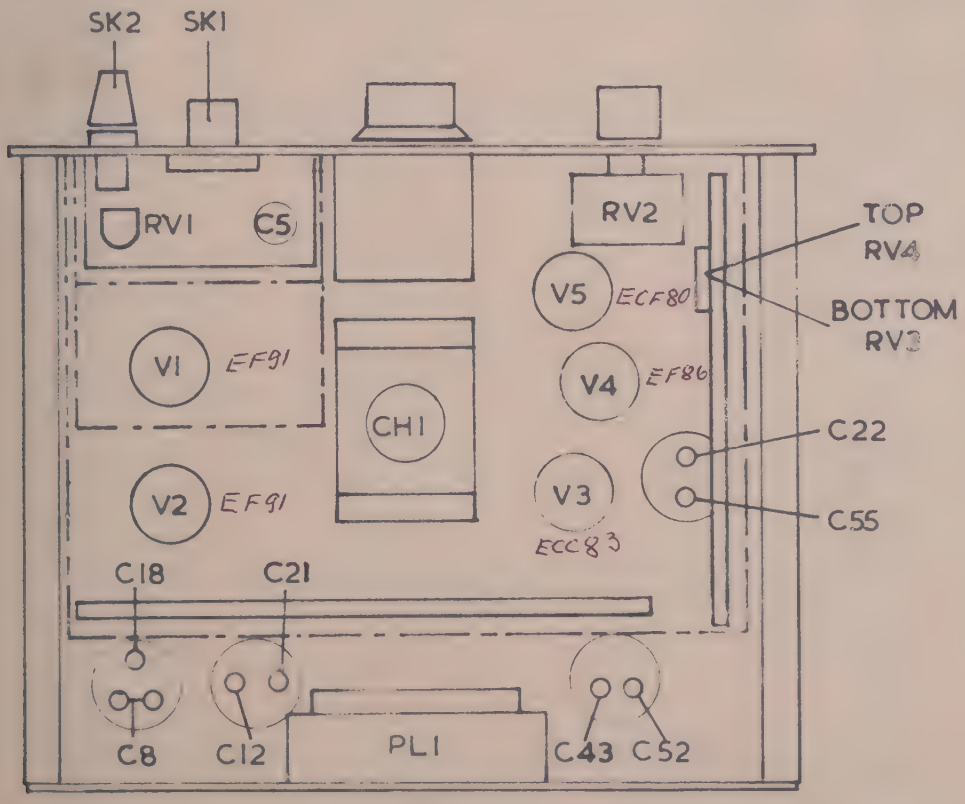
RV1.	Linear	1KΩ
RV2.	Linear Wirewound	50KΩ
RV3.	Linear	4.7KΩ
RV4.	Linear	4.7KΩ

M I S C E L L A N E O U S

CH1.	Chopper with Magnetic screen. A.E.I. CK3.
S1.	Switch Dymar Drg. No. BD.1379
PL1.	Plug 16-way Dowel McMurdo R.P.D.16. Polarised
PL2.	Free Plug Greenpar Eng. GE40051 Reducing Adaptor " " GE40008
SK1.	Co-axial Connector U.H.F. Greenpar Eng. GE40029.
SK2.	Terminal, type L1568/E/Black Belling & Lee.



VIEW ON TOP OF CHASSIS

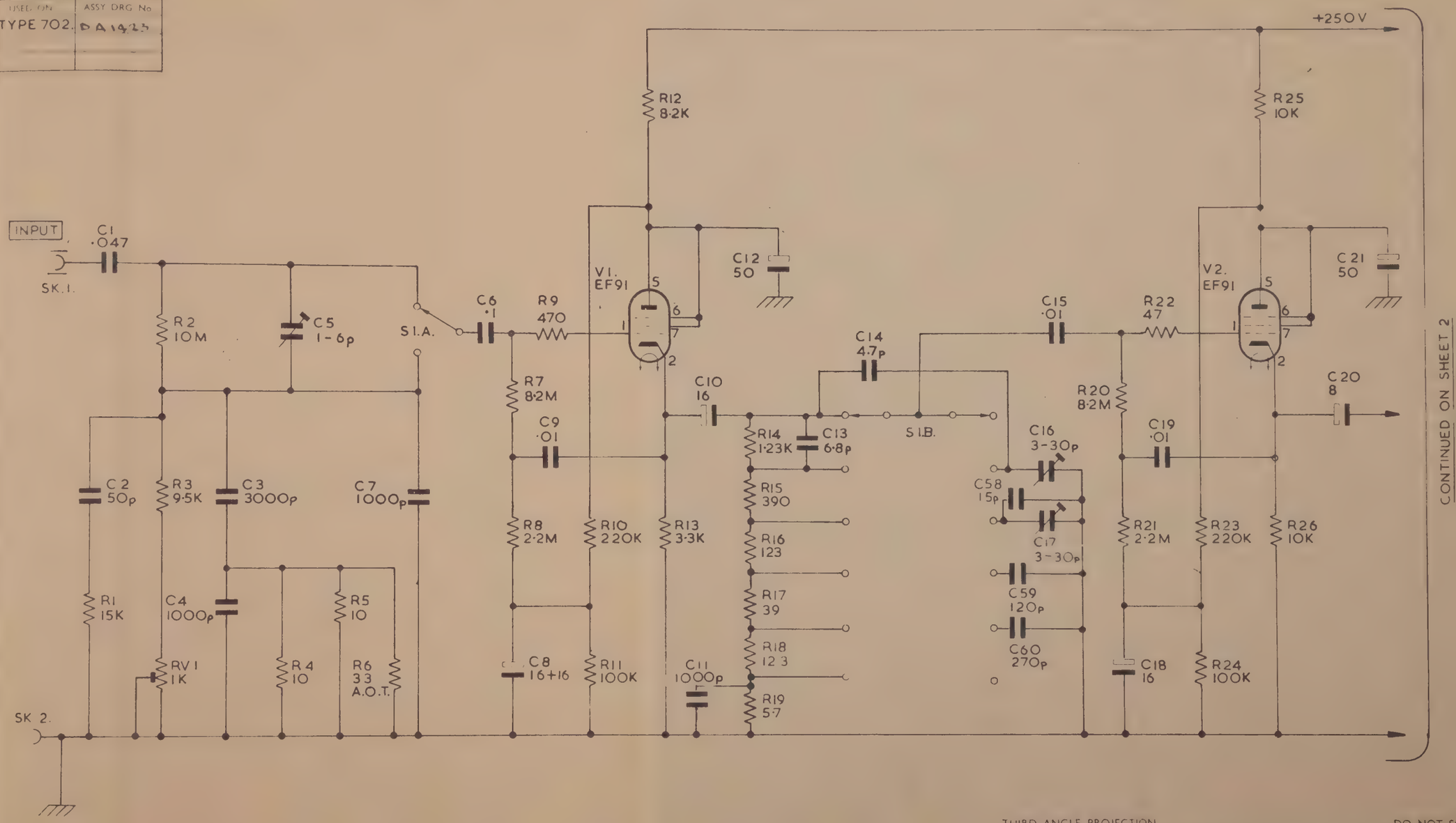


VIEW UNDER CHASSIS

DRG No. BC1366

USED ON	ASSY DRG No
TYPE 702.	DA1425

ISSUE 1 31.7.67



THIRD ANGLE PROJECTION

DO NOT SCALE

LIMITS UNLESS OTHERWISE STATED AS FOLLOWS	
FRACTIONAL DIMENSIONS ·015	CLEAR HOLES ± ·005
DECIMAL DIMENSIONS ·005.	ANGLES ½°
DIMENSIONS APPLY BEFORE PLATING UNLESS OTHERWISE STATED	
MAT'L	SPEC.
FINISH	
ALL DIMENSIONS IN INCHES	SCALE

DYMAR ELECTRONICS LTD.
WATFORD, HERTS, ENGLAND.

TITLE
CIRCUIT DIAGRAM.
TRUE R.M.S. MILLIVOLTMETER

DRG. No. BC1366 SHEET. 1 OF 3.

DRN. M.G. PERLE DATE 11:3:67

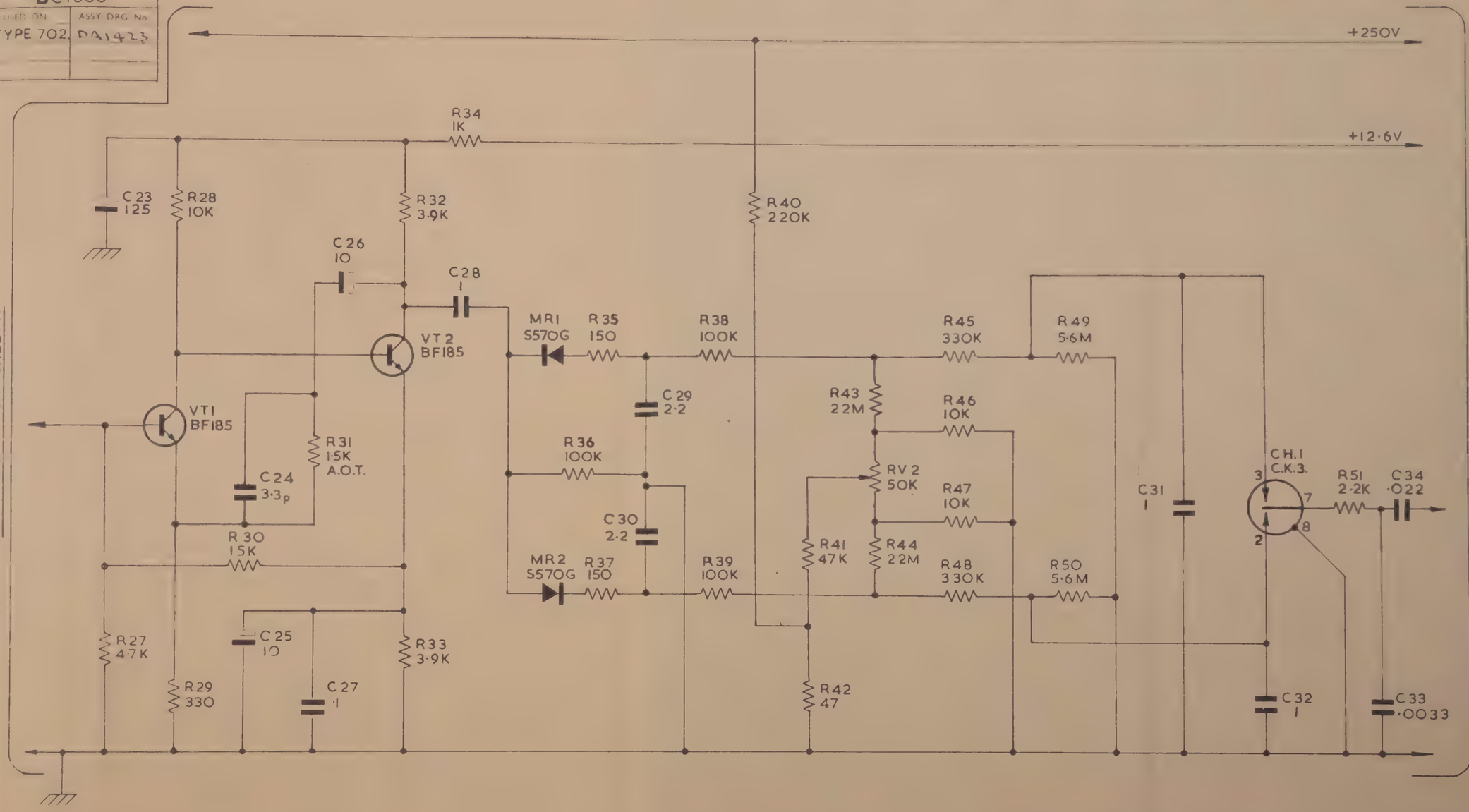
CHK'D DATE

APP'D. DATE

DRG. No. BC1366

USED ON	ASSY. DRG. No.
TYPE 702.	DA1423

1. 31. 7 67.



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DECIMAL DIMENSIONS ·· ·005. ANGLES ½°
DIMENSIONS APPLY BEFORE PLATING UNLESS OTHERWISE STATED

MAT^L SPEC.
FINISH
ALL DIMENSIONS IN INCHES SCALE

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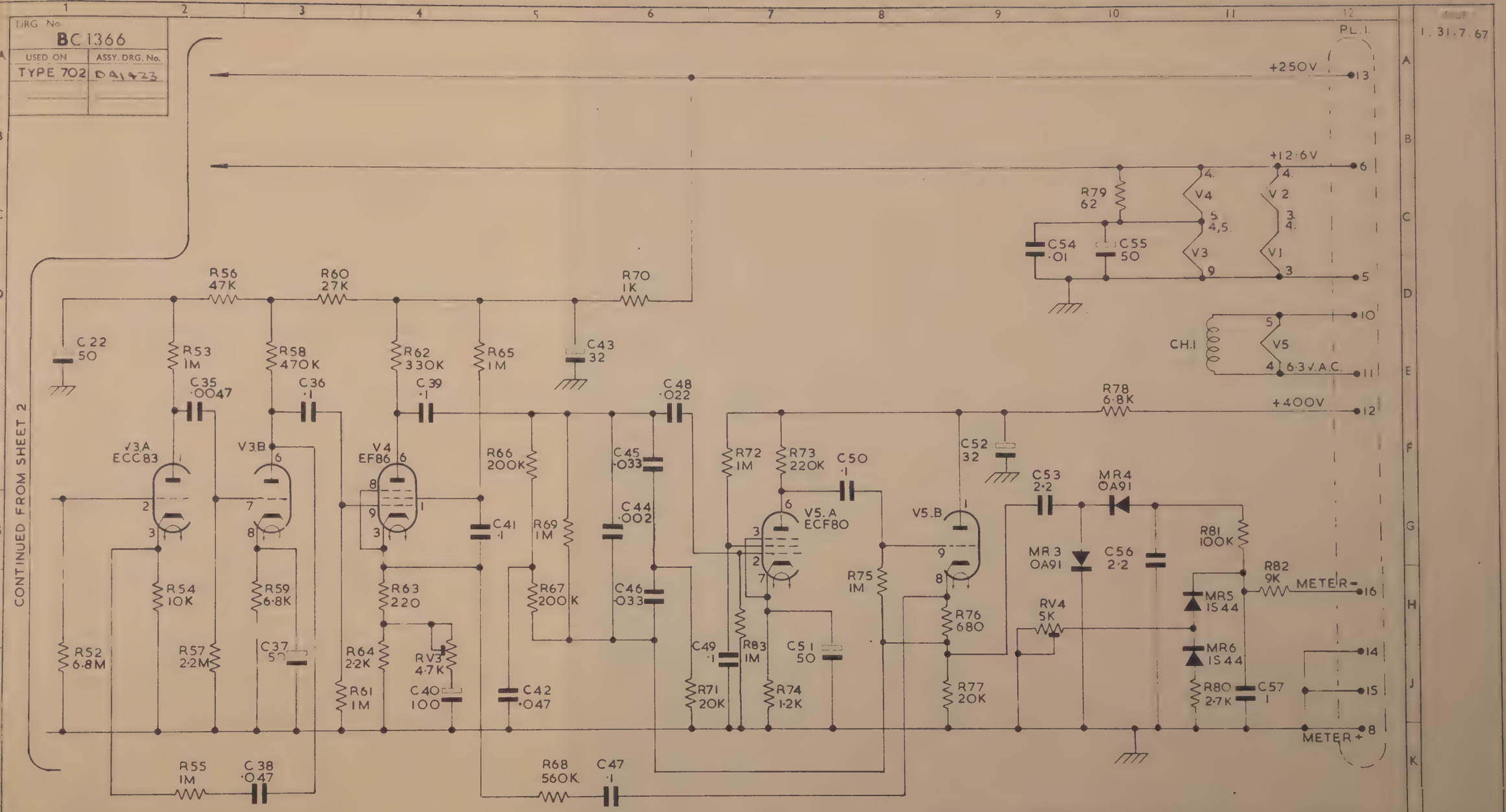
CIRCUIT DIAGRAM.
TRUE R.M.S. MILLIVOLTMETER.

DRG. No. BC1366 SHEET 2 OF 3.

DRN M G PERLE DATE 11·3·67
CHKD DATE
APPD DATE

DRG No	
BC1366	
USED ON	ASSY. DRG. No.
TYPE 702	DA1423



LIMITS UNLESS OTHERWISE STATED AS FOLLOWS		
FRACTIONAL DIMENSIONS ± ·015.	CLEAR HOLES ± ·005	
DECIMAL DIMENSIONS ± ·005.	ANGLES ± ½°	
DIMENSIONS APPLY BEFORE PLATING UNLESS OTHERWISE STATED		
MAT'L.	SPEC.	
FINISH		
ALL DIMENSIONS IN INCHES	SCALE	

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TITLE
CIRCUIT DIAGRAM
TRUE R.M.S. MILLIVOLTMETER.

DRG. No BC1366 SHEET 3 OF 3

DRN M.G.PERLE. DATE 11.3.67

CHK'D DATE

APP'D DATE

1. 31. 7. 67

G U A R A N T E E

In lieu of any warranty, condition or liability implied by law, our liability in respect of any defect in or failure of the goods supplied, is limited to making good by replacement or repair defects which, under proper use by the original purchaser, appear therein and arise solely from faulty materials or workmanship within a period of twelve calendar months after the original goods shall have first been dispatched, at the termination of which period all liability on our part ceases; provided always that such defective instruments are carefully packed and returned free to our Works unless otherwise arranged, and provided that they have not been tampered with in any way.

For components not of our manufacture we extend only such benefits as we may receive under any Guarantee given to us by the makers thereof.

The liability of the Company for consequential loss or damage suffered by the Purchaser of the goods supplied by it, however sustained is hereby expressly excluded.

Our equipment has been designed and tested for use with the specific types of components supplied by us therein and no responsibility can be accepted for the performance of the equipment if other components are employed.

****

In the event of failure or malfunctioning of any equipment supplied by us please contact our Service Department, at the below stated address and give full details of the fault together with the Type and Serial Number of the equipment in question.

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Telephone: WATFORD 21297/8/9

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MA23515